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ABSTRACT

This paper offers a concept for overcoming some problems in classroom observation research stated in the following three propositions: (1) there is a logical gap between available means for describing teacher behavior using observation schemes and the larger purposes of education; (2) classroom observation instruments have neglected descriptions of teaching which emanate from philosophical analysis of the concept of teaching; and (3) classroom observation research has tended to focus on empirical predictions which are not directly related to educational goals and objectives, rather than on logical predictions which have the achievement of educational goals as their target. It is shown that it is possible to use the concept of intellectual independence to establish an observation scheme for analyzing science teaching. Examples of the scheme in use are provided to demonstrate how science teaching can be described in terms of epistemological features. Using this approach, it is possible to make sound judgments about the intellectual quality of science teaching and to make logical predictions about the contribution such teaching can make to a learner's intellectual independence. (MN)

ANALYZING TEACHING:
THE QUALITY OF THE INTELLECTUAL EXPERIENCE AND THE CONCEPT OF INTELLECTUAL INDEPENDENCE.

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Introduction

Anyone venturing into the field of classroom interaction research is faced with a considerable problem by virtue of the extensiveness of the heritage in this active corner of educational inquiry. Unless there is time and space for a large book, he must be excused from elaborate and detailed reviewing, and charged instead to offer good cause for a fresh attempt, and a cause that is radically different from the prospect of a tie-breaking study. This paper, then, will omit a roll call of classroom observation studies which show statistical significance and insignificance between pieces of verbal conduct and incremental growths in what youngsters are said to have learned. (Berliner[1] has articulated excellently the weaknesses of such studies, and a thorough review is given by Dunkin and Biddle[2].)

The argument to be advanced here is set atop three related propositions for which it would be unwise to assume any credit. These propositions are:

PROPOSITION I:

> There is a considerable distance between available means for describing teaching behavior (using an observation scheme), and the larger pruposes of education which, presumably, all small instances of teaching are collectively attempting to achieve.

The distance referred to here is of two sorts. There is first the troublesome realization that we have few assurances that the mass of objectives in classes and courses taken over the years sum to the attainment of educational goals typically

stated by school boards and so forth. Second, the descriptions arising from observation devices generally do not describe teaching behavior in terms of educational goals or objectives. For instance, to take a model case, that a piece of teaching is awarded an indirect/direct ratio of 1.3 tells us nothing about the sort of education learners are receiving, although it is presumed to describe something of the nature of the experience.[3] In short, then, we have no device that permits us to observe a lesson and then describe it in terms of an educational goal.

PROPOSITION II:

> Classroom observation instruments, which offer descriptions of teaching, have largely neglected the rich and clear descriptions of teaching which have emanated from philosophical analyses of the concept of teaching itself.

A decade ago, Komisar[4] commented that research findings, ". . . are just as helpful to the propagandist or indoctrinator as they are to the teacher. This is because the aspects of 'classroom interaction' current research focuses on are not peculiar to the teaching encounter but are common to all ways man contrives to mold the minds of other men." Since philosophy of education has in part been concerned with the concepts that characterize the enterprise, it is not surprising that there has been much activity in clarifying terms such as teaching, learning, indoctrinating, miseducating, and so forth. And, since these terms are intimately bound to concepts of education, classroom interaction research is probably the poorer for not

employing them.

PROPOSITION III:

> The core of research and discussion on teaching and learning (and indeed of planning for teaching and learning) is prediction, yet classroom interaction research has tended to focus on impirical predictions (which are not directly related to educational goals and objectives) rather than on logical predictions which have the achievement of educational goals and objectives as their target.

Empirical predictions (or, empirically based predictions) are of the sort: if the climate of the class, as established by the teacher, is such and such, then learning will be improved. (This is the typical form to make the point, it being understood that the evidence cannot always sustain the prediction.) A logical prediction speaks to the provisions made by a teacher's actions. At root, a logical prediction for teaching and learning has the form, "If I teach X to A, then provision is made for A to learn X." So, if we wish youngsters to learn the development of the periodic table of elements, then a logical predittion about learning requires that all relevant information and argument be presented. Other information, such as operating a triple beam balance can be excluded, for it cannot make the smallest provisions for the objectives set.

The problem that this paper seeks to solve is to begin filling the gap alluded to in the first two propositions while maintaining the educational integrity of the third. This

objective will be achieved in the following manner. First, a new concept for classroom observation is stated which is clearly related to a recognizable educational goal or ideal. Next, the distinctive features of the concept are displayed, and this is achieved by way of illustration in a brief epistemological analysis. Lastly, it is shown that the features of this concept can be used to describe classroom interaction qualitatively and accurately.

The Concept Intellectual Independence

Hitherto, the majority of studies on the relationship between measures of classroom climate and student achievement have relied upon what might be termed a quasi-sociological interpretation of classroom climate. The model case, if it can tolerate the label, is surely the Flanders System for interaction analysis.[5] Flanders, in "Teacher Influence in the Classroom," traces the pedigree of his system to studies in the thirties and defines classroom climate thus:

> The words classroom climate refer to generalized attitudes toward the teacher and the class that the pupils share in common in spite of individual differences. The development of these attitudes is an outgrowth of classroom social interaction. As a result of participating in classroom activities, pupils soon develop shared expectations about how the teacher will act, what kind of a person he is, and how they like their class. These expectations color all aspects of classroom behavior, creating a social atmosphere or climate that appears to be fairly stable, once established. Thus the word climate is merely a shorthand reference to those qualities that consistently predominate in most teacher-pupil contacts and contacts between pupils in the presence of the teacher.[6]

For two reasons, it seems useful to entertain a radically different way of defining classroom climate. First, the earlier

allusions of this argument to research using the Flanders System and its progeny suggest a lack of definitive correlations between classroom climate (sociologically defined) and student achievement. Second, while there are alternative sources for defining classroom climate, such as the psychology of learning and the structure of the intellect, which have provided the conceptual underpinnings of such observation instruments as those of Taba and Gallagher[7], the rich source of concepts from educational philosophy appears not to have been tapped. So, notwithstanding the thorough work of Smith and Meux[8] in describing teaching in terms of logical moves and strategies, the burden of work on classroom climate tends to depict the emotional, social, and cognitive topology of lessons, while leaving unnoticed the possibility of characterizing teaching in terms of its intellectual climate.

The matter of establishing concepts which can speak to the intellectual climate of a classroom may be broached by considering how different sorts of teaching can influence students' judgment of claims to truth. There is, for example, a clear conceptual distinction between teaching which allows students to judge the truth of knowledge claims independently, and teaching which leaves students dependent upon their teacher for judgments of truth. ("It must be true, 'cos the teacher said so!" aptly captures the latter.) The availability or lack of evidence or argument to support knowledge claims has potential for influencing the extent to which learners can judge claims for

themselves. Immediately, then, the potential of epistemological considerations for describing teaching surfaces.

This line of thought leads directly to the concepts Intellectual Independence and Intellectual Dependence, which can be defined as follows. An individual can be said to be intellectually independent when he has all the resources necessary for judging the truth of a knowledge claim independently of other people. Thus, an individual judging the truth of a claim on the basis of all assumptions, evidence and arguments necessary for that judgment is exercising Intellectual Independence. (Similar conditions obtain for Intellectual Independence in the adoption or rejection of values, views of science, and views of the world.) If, for lack one or more of the conditions necessary for Intellectual Independence, an individual is obliged to rely upon someone else's authority, then it is said that the first individual is intellectually dependent upon the second.

The concept of Intellectual Independence can readily be seen to assume the status of an educational goal, in an idealized formulation. And, if the third proposition, above, is kept in view, it seems entirely possible to describe teaching as providing for Intellectual Independence or for Intellectual Dependence. In this way, the problem noted in proposition I, above, will be dissolved, for there will be a device permitting interested observers to describe instances of teaching in terms of whether or not those instances provide for an educational goal. In short, it looks as if teaching discourse can be described in terms which

reflect its intellectual climate.

Neither is the description "providing for Intellectual Independence or Intellectual Dependence" restricted in its application to what is said by a teacher. Typically, students offer claims, and the fashion in which a teacher treats these can expose further the intellectual climate of a classroom. For instance, in order that a student see for himself why his offering is valid or invalid, the teacher must ensure that the criteria by which the statement is judged are evident in the discourse. If reasons for accepting or rejecting a student's statements are not explicit, then again, the student is intellectually dependent upon the teacher for judging the validity of the offering. But if reasons <u>are</u> given, then the student can judge the validity of the statement for himself. The underlying notion here is that students might be given or denied the prerogative of having their intellectual contributions treated with proper regard to reason.

Importantly, it is not sufficient for a teacher to say "Yes" to a student's offering, if Intellectual Independence is being aimed for. Although the response "Yes" is said to be "positively reinforcing", it does not by itself provide <u>reasons</u> for the correctness of the offering. The learner may gather that he is right but not know why.

Here then we see that the emphasis in discussing intellectual climate is upon the <u>rationality</u> with which student offerings are treated, and not upon the teacher's <u>cordiality</u>, the latter

properly belonging to notions of social climate.

Determining the Features of Intellectual Independence:

1. The Conceptual Analysis

As described above, the notion of Intellectual Independence implies an educational aim or ideal, for it describes a mental state whose attainment by students might be the aspiration of their teachers. But, if this concept is to have value for analyzing teaching, it must be sufficiently articulated to yield features that are readily transformed into a scheme for observing and analyzing teaching. The burden of this task is undertaken in this section.[9]

The suggestion that Intellectual Independence could become a tool for describing the intellectual climate of teaching and for characterizing the rationality of the discourse, rather than its cordiality, leads quite directly to the thought that a useful starting point for discovering features of the concept lies in what have come to be known as the traditional three conditions of knowledge. In an early work, Scheffler finds that the following conditions must be satisfied in order for someone to be said to know a proposition:[10] first, the person must believe the proposition; second, the person must have adequate evidence for the proposition; and third, the proposition must be true. Scheffler's subsequent analysis of these conditions can be turned to advantage by asking what conditions must be fulfilled within teaching discourse if a student is to know a proposition, as

distinct, say, from merely believing it. Without pursuing the argument too fully, we can say that the evidence and truth conditions must be satisfied. Or, to put the matter into the terminology of this paper, it would appear that teaching would go some distance toward providing for Intellectual Independence were the evidence and truth conditions satisfied for each proposition uttered by the teacher.

These conditions require brief examination so that their implications and limitations can be turned to present purposes. As Scheffler has noted, one striking limitation of the evidence condition is that it simply doesn't apply to claims such as analytical claims for which evidence is inappropriate. The evidence condition, then, needs some modification, and this is achieved by noting that propositions are to be supported by evidence, reason, and argument. Second, the evidence condition fails to honor the place of conflicting evidence or reasons. A minor adjustment allows us to see that teaching which provides for Intellectual Independence should acknowledge to students that there is conflicting evidence and that the supporting evidence is limited, so that learners are in a position to make judgments about the claims in question.

In its current form, the truth condition's major drawback is that it appears to ignore the wealth of problems which revolve around the question of what precisely can be said to constitute truth. For instance, an analysis of the criteria for truth in science reveals that such criteria are dependent upon

quite different views about the nature of science. As a consequence, it would be difficult to judge a portion of science teaching on the basis of the truth of what is asserted, for this would require one to commit himself to a particular position about truth and the nature of science. So, in the spirit of the present inquiry it becomes more significant to examine science teaching for the presence or absence of explicit statements about means for assessing truth. Thus, rather than analyze science teaching for the truth of what is asserted, one can analyze teaching to see if means for determining truth are made evident to students in order that they can better assess the truth of statements for themselves. Of course, when teaching contains this information it moves decidedly toward providing for Intellectual Independence. This foregoing development of the concept of Intellectual Independence and Intellectual Dependence has been restricted to the fashion in which propositions are treated in teaching. Yet the concept is broader, and this can be seen when one considers activities in teaching which are somewhat different from the making of claims about the world. For instance, if students are to be able to judge the appropriateness of models or diagrams that are used in teaching, then evidence and argument must be available to show that these do correspond to what they are meant to represent. If these conditions are met, students can exercise Intellectual Independence. Furthermore, since Intellectual Independence speaks of a capacity for making rational judgments, then alternatives must be available for

students to judge between. So, teaching that provides for Intellectual Independence would be characterized by the presense of alternative theories, say. But if alternatives are absent, then judgments of this sort are preempted. Such teaching would provide for Intellectual Dependence.

As was mentioned earlier, the notion of Intellectual Independence is not confined to the explicit and implicit propositional assertions of teaching, for it can be shown that the concept has added usefulness since it permits a characterization of teaching according to the manner in which students' statements are treated. A comparison between classroom discourse and other forms of social discourse yields useful information about this aspect of teaching which stems from considering the prerogatives of those engaged in various forms of discourse.

Generally, verbal interactions are characterized by the intrusion of the speakers upon each others perceptions; yet the participants are usually at liberty to prevent further intrusion by requesting that the interaction cease. Another characteristic of general verbal interaction is that it carries with it no coercion for taking physical or intellectual action upon the request of a participant. So neither participant is especially empowered with prerogatives which would permit him to coerce the other into any form of course of action. The absence of any legal or logical permissions to coerce allows much freedom for legitimately declining to take action.

Such contractual prerogatives may be detected in classrooms,

and these are quite distinct from the legal obligation upon students to attend and teachers to teach. A feature that distinguishes the prerogative of classrooms from those inhering in other societal institutions is the seemingly undisclosed nature of the classroom prerogative. In the classroom setting, a student may be thought of as entering a contract to have something done to him, but at the time when he enters the contract he logically cannot be aware of the full extent of what is to be done, for he has yet to submit to teaching. For this reason the nature of the contract entered by the student remains undisclosed and will probably remain so until the outcome of teaching is attained, at which time, of course, the contract can be thought to expire. Alone, this suggests that a student has no prerogatives for counteracting the intrusion of teaching upon his perceptions, and <u>that</u> appears characteristic of all teaching.

If, however, teaching is seen to make provision for Intellectual Independence, then it is possible to establish that a student is being permitted to exercise prerogatives which partly offset the intrusiveness of teaching. Most basically, Intellectual Independence involves the capacity for making judgments about knowledge claims for oneself. It has been seen that provision of evidence in support of such claims and "seeing" how their truth is determined are necessary conditions for making such judgments. Accordingly, when a student is provided with these conditions and permitted to judge claims for himself, his potential for Intellectual Independence is being honored. This, in turn, permits

him to order his perceptions about the world in such a way that he is aware of what he is doing and why, as opposed to requiring him to order them in some prescribed fashion. And this allowance may be interpreted as giving a student the right to exercise a prefogative that is his alone, that of choosing how he will order his experiences--a responsibility that is ultimately his.

Thus students have prerogatives in the teaching discourse, and what bears upon the consequences of the discourse is the extent to which they are permitted to invoke these prerogatives. If provision is being made for Intellectual Independence, then these prerogatives can be used by learners to offset the intrusiveness of teaching, to the extent that they are equipped with means to judge the teaching to which they submitted. Alternatively, teaching that provides for Intellectual Dependence does not permit judgment of the content taught, so it prevents students from using their prerogatives.

So, respecting the personal prerogatives of students seems closely allied with providing for Intellectual Independence. Alternatively, if these prerogatives are not respected, then it seems that teaching provides for Intellectual Dependence. For instance, if a student offers a response to a question then it would appear that he has the right or prerogative to have that response honored and treated with due regard to reason. A response rejected out of hand clearly violates this prerogative, for the teaching can be seen as failing to comply with other features of teaching which provide for Intellectual Independence,

such as the provision of evidence or argument. Consequently, when a response or an unsolicited offering is not honored nor treated with regard to reason, that portion of teaching can be characterized as providing for Intellectual Dependence.

Determining the Features of Intellectual Independence:

2. The Heritage from Analyses of the Concept "Teaching"

The second proposition of this paper bemoans the omission of philosophical analyses of "teaching" in the conduct of empirical research on teaching. In this section, the effort is to show that the concepts Intellectual Independence and Intellectual Dependence owe much to the analysis of the concepts teaching and indoctrinating respectively. Two accounts of each are selected to reveal this ancestry.

Scheffler provides this normative account of teaching:

> Teaching may be characterized as an activity aimed at the achievement of learning, and practiced in such manner as to respect the student's intellectual integrity and capacity for independent judgment. Such a characterization is important for at least two reasons: first, it brings out the intentional nature of teaching, the fact that teaching is a distinctive goal-oriented activity, rather that a distinctively patterned sequence of behavioral steps executed by the teacher. Secondly, it differentiates the activity of teaching from such other activities as propaganda, conditioning, suggestion, and indoctrination, which are aimed at modifying the person but strive at all costs to avoid a genuine engagement of his judgment on underlying issues.[11]

For Scheffler, respecting a student's intellectual integrity requires that teaching discourse gives the student the right to a confidence in his beliefs by building an appropriate case for them. If the student's capability for independent judgment is to

be respected, then reason, argument and evidence must be provided. Such a description of teaching coincides closely with the concept of Intellectual Independence.

The second selected example is from Komisar who distinguishes activities such as propagandizing and indoctrinating from teaching, by focussing our attention on a special form of teaching which he terms, "teaching at the act level."[12] When we speak of teaching in this way, we refer to the presence of intellectual acts, such as proving, demonstrating, explaining and the like.

Such intellectual acts will unquestionably provide for Intellectual Independence. Consider a teacher proving something. If the term "proving" is used here appropriately, then all the pieces of the proof may be presumed present. That the student has access to these provides for Intellectual Independence. Yet, if a teacher were attempting a proof and omits a part of it, then it would be quite wrong to honor his attempt with the name of the act. The upshot of this enterprise is to leave the student Intellectually Dependent upon the teacher.[13]

Much of the analysis of "indoctrination" has been concerned with the teaching of morals and religion in schools.[14] Flew has suggested that indoctrination may be considered as having a primary and secondary sense. In the primary sense, "indoctrination" describes the implanting of doctrines which are false or not known to be true, and in the secondary sense "indoctrination" applies to the implanting of doctrines by disapproved methods.[15] The primary sense, then, has an impact similar to providing for

Intellectual Dependence, for a teacher cannot intend to propagate falsities, and at the same time provide a comprehensive means for determining their truth.[16]

Similarly, Flew's secondary sense of indoctrination suggests that its outcome is intended to be Intellectual Dependence. If the intent is to implant doctrines, then it might be necessary to withhold evidence and argument, especially if students are critical of the doctrines. But there is a difficulty with Flew's secondary sense for it contains the criterion of disapproved methods. One might approve the withholding of evidence and argument in certain situations, and so that process might not qualify as indoctrination. All the same, the potential consequence of that process is still Intellectual Dependence.

Green provides an analysis which seems to place Intellectual Dependence as the potential consequence of indoctrination. He addresses himself to the task of sorting and arranging along a continuum verbs within the family of "teaching verbs." This continuum extends from actions to beliefs and makes distinct indoctrinating and instructing. The latter, Green suggests, involves matters of truth and falsity, whereas indoctrinating" . . . aims simply at establishing certain beliefs so that they will be held quite apart from their truth, their explanation, or their foundation in evidence.[17] Patently, the potential outcome of indoctrination and teaching that provides for Intellectual Dependence are the same. Both leave the recipient of the act dependent upon the perpetrator for assessing the truth of statements transmitted

during the act.

Conclusions

The point of the preceding has been to show that it is possible to characterize teaching in terms of its intellectual climate. It has been shown that the concepts Intellectual Independence and Intellectual Dependence are well suited to this task, and that the concepts refer to larger educational aims, as well as incorporate some of the more fertile products of conceptual analysis in educational philosophy.

The upshot of the analysis has been a list of features which teaching will possess if it provides for either Intellectual Independence or Intellectual Dependence, and these are summarised in the form of an analytical scheme in Appendix A.

The final point is to show that such a scheme can be used, and brief extracts from transcripts of science lessons appear in Appendix B to that end. These extracts are coded according to the features of the analytical scheme: the one providing for Intellectual Independence and the other for Intellectual Dependence. Coding may be performed in two ways. First, a lesson could be subdivided into episodes similar to those appended, and then each episode judged. Second, a lesson could be coded every thirty seconds, and a judgment made about the degree to which Intellectual Independence and Intellectual Dependence are provided for, using a five point scale.

Notes and References

1. Berliner, David C., "A Status Report on the Study of Teacher Effectiveness." Journal of Research in Science Teaching, volume 13, number 4 (1976), pp. 369-382.

2. Dunkin, Michael J. and Bruce J. Biddle, The Study of Teaching. New York: Holt, Rinehart and Winston, Inc., 1974.

3. It could be objected that significant correlations between types of teaching behavior and student achievement invalidate this claim; but statistically significant evidence from studies which satisfy Berliner's concerns appears to be minimal.

4. Komisar, B. Paul, "Questions for Research on Teaching." Classroom Interaction Newsletter, volume 3, number 1 (December, 1967).

5. Flanders, Ned A., Analyzing Teacher Behavior. Reading, Massachusetts: Addison-Wesley Publishing Company, 1970.

6. Flanders, Ned A., "Teacher Influence in the Classroom." In Interaction Analysis: Theory, Research and Application. Edited by Edmund J. Amidon and John B. Hough. Reading, Massachusetts: Addison-Wesley Publishing Company, 1967, pp. 103-104.

7. The Taba and Aschner-Gallagher systems may be found in Mirrors for Behavior III: An Anthology of Observation Instruments. Edited by Anita Simon and E. Gil Boyer. Wyncote, Pennsylvania: Communication Materials Center, 1974.

8. The systems of B. O. Smith and Milton O. Meux are also in Mirrors for Behavior III. Ibid.

9. The analysis presented here is a greatly reduced version of appears in A. Hugh Munby, "The Provision Made for Selected Intellectual Consequences by Science Teaching: Derivation and Application of an Analytical Scheme." Unpublished doctoral dissertation, University of Toronto, 1973.

10. Scheffler, Israel, Conditions of Knowledge: An Introduction to Epistemology and Education. Glenview, Illinois: Scott, Foresman and Company, 1965.

11. Scheffler, Israel, "Philosophical Models of Teaching." Harvard Educational Review, volume 35 (Spring, 1965), pp. 131-143.

12. Komisar, B. Paul, "Teaching: Act and Enterprise." In Concepts of Teaching: Philosophical Essays. Edited by C. J. B. Macmillan and Thomas W. Nelson. Chicago: Rand McNally and Company, 1968, pp. 63-88.

13. Other analyses of the concept "teaching" may be found in Concepts of Teaching: Philosophical Essays, ibid., and in Philosophical Essays on Teaching, edited by Bertram Bandman and Robert S. Guttchen. Philadelphia: J. B. Lippincott Company, 1969.

14. An exception may be found in Douglas A. Roberts, "Science Education Viewed as an Indoctrination Process." Presented at a symposium, "The Limitations of Scientific Literacy", at the 1972 Convention of the National Science Teachers Association, New York.

15. Flew, Anthony, "What is Indoctrination?" Studies in Philosophy and Education, volume 5 (Spring, 1966), pp. 281-306.

16. While the intended outcome of indoctrination is necessarily Intellectual Dependence, this does not imply that all teaching which provides for Intellectual Dependence is indoctrination. Indoctrination is said to be intentional, and it is possible that a teacher provides for Intellectual Dependence without intending to do so.

17. Green, Thomas F., "A Topology of the Teaching Concept." In Philosophical Essays on Teaching, op. cit.

Appendix A

The Analytical Scheme

II INTELLECTUAL INDEPENDENCE

Statements which present the intellectual undergirding of knowledge claims (evidence and arguments) in such a way that the listener has the data to make his own judgments.

a. Evidence is provided in support of claims.

b. The argument is present.

c. Correspondence of diagram or model to phenomena is demonstrated by argument and evidence.

d. Adequate reasons given for the acceptability or unacceptability of a pupil's statement or response.

e. Suggestions, questions, and objections of pupils are honored and are treated with regard to reason.

f. Pupils have provision to make judgments of the viability of models, theories, and explanations by recourse to phenomena.

g. Alternative models, theories, and explanations are provided to permit pupils to make judgments among them.

h. Discrepancies among observations or evidence are rationally resolved.

ID INTELLECTUAL DEPENDENCE

Statements which present a knowledge claim in such a way that the listener is dependent upon the speaker for making a valid judgment about the claim.

a. Evidence is not provided in support of claims.

b. The argument is absent.

c. Correspondence of diagram or model to phenomena is not demonstrated by evidence or by argument.

d. Adequate reasons for the acceptability or unacceptability of a pupil's response are absent.

e. Suggestions, questions, and objections of pupils are not honored or are not treated with regard to reason.

f. Provision is not made for pupils to make judgments of the viability of models, theories, and explanations by recourse to phenomena.

g. The making of judgments among alternative models, theories, and explanations is preempted since alternatives are not provided.

h. Discrepancies among observations or evidence are not resolved on rational grounds.

Appendix B

Examples of the Scheme in Use

II INTELLECTUAL INDEPENDENCE

Item		Example
II-a	T:	(Pointing to the hot beaker) What is happening to the potassium permanganate?
	P:	It's diffusing faster than the cold one.
II-b	T:	Now, to see if this is a good theory, we have to predict something with it and then test our prediction. We saw our prediction was correct, so we can say it's a good theory.
II-c	T:	Now, we're trying to see if the ball behaves in the same way that light behaves. We got angle of incidence equal to angle of reflection with light and with the ball--our model of light.
II-d	P:	Perhaps the charge thing moves along the glass rod.
	T:	Now wait. From the experiment, glass doesn't conduct, does it? So that explanation won't work.
II-e	P:	Won't end "B" of the iron bar repel end "D" of the other bar?
	T:	Why do you think that'll happen?
	P:	Well, er, because... (P provides reasons).
II-f	T:	So we have two theories: single-fluid and double-fluid, say. Which one seems to be supported by your results?
II-g	T:	But there's another way of looking at this. Suppose we think of light as wave-like instead of particle-like.
II-h	P:	Hey, we got a height of 36.8 centimeters.
	T:	Oh, Er, perhaps we'd better repeat that measurement to be sure we haven't got an error.

ID INTELLECTUAL DEPENDENCE

Item		Example
ID-a	T:	There are 600,000 different kinds of insects.
ID-b	T:	Since it did travel faster, what do you suppose its density is?
	P:	Lighter?
	T:	Yes. Lighter than the other one because it travelled faster. (No argument is presented which relates speed and mass.)
ID-c	T:	(Holding up a model made of styrofoam balls): This is a model of a salt crystal. (T then proceeds to another topic, no mention being being made of the relationships among conceptual model, physical model, and observations.)
ID-d	T:	What else do living things have in common?
	P:	All living things die.
	T:	Well, yes. But that's not what I want.
ID-e	P:	People aren't animals, they're humans.
	T:	People <u>are</u> animals, the same as cats and dogs and so on. They're not plants are they? (T moves to another topic.)
ID-f	T:	What produces static electricity, then?
	P:	Friction.
	T:	Right. (T continues with some definitions and demonstrations, but doesn't relate data to the idea of friction "producing" static electricity.)
ID-g	T:	Modern atomic theory states that the atom is composed of... (T describes the theory and the observations it supports. No mention is made of former theories nor of how they deal with the same observations.)

Item	Example
ID-h	T: How many of you got the bulb to light up when you used solution E? (Several hands are raised.)
	P: It didn't work with us.
	T: Did anyone else not get it to light in E? (Silence, no hands are raised. T proceeds without further reference to the anomaly.)